Hyperbaric Oxygen Therapy for Diabetic Ulcers, Canterbury, NZ

Summary

- Hyperbaric oxygen therapy (HBOT) improved healing in five prospective randomised trials of diabetic ulcers and reduced the rate of major amputation in two of these.[1-5]
- HBOT has been shown to be cost-effective even though it is a moderately expensive therapy.[4]
- After HBOT, healing is maintained in the medium to long term because vascular neogenesis is promoted.[1,5,6]
- Complication rates of HBOT are low and treatment is well tolerated by the majority of patients.
- HBOT must be used in conjunction with good wound care and an holistic approach to the patient. This requires a multi-disciplinary approach to problem wound management.

The clinical evidence for HBOT

Five small, prospective randomised trials of HBOT for diabetic ulcers have now been published.[1-5] All show improved healing, and in two a reduction in major amputation rate was reported (Table 1). Follow-up studies suggest these benefits are maintained in the medium to long term (three to five years).[6] Improved healing rates and an approximate halving of major amputation rates has been reported consistently in several other partly or non-randomised clinical studies and case series.[6-8] A recent Cochrane review identified the need for further large randomised studies to validate these data, but concluded that, where it is available, HBOT should be employed for diabetic ulcers.[9]

Table 1 Summary of randomised studies of hyperbaric oxygen therapy in diabetic and non-diabetic ulcers

Study	Patients	Outcome measure	Results HBO	Statistics	Comment	Control
Kalani et al[1]	38	Healed ulcer	13/17	10/21	p<0.05	follow-up 3 yr
		Major Amputation	2/17	7/21	p<0.05	follow-up 3 yr
Faglia et al[2]	68	Major Amputation	3/35	11/33	p<0.02	
Doctor et al[3]	30	Major Amputation	2/15	7/15	p<0.05	weekly HBOT
Abidia et al[4]	18	Healed ulcer at 1 yr	5/8	1/8	p=0.026	saving approx.
		Wound area decrease	100%	52%	p=0.027	$8000 per pat
Hammarlund[7] & Sundberg	16	Wound area decrease at 6 weeks	35.7%	2.7%	p<0.001	Diabetic and non-diabetic ulcers
Lee et al[5] (Abstract only)	37(32)	Wound healing time not stated in abstract	4/20	4/12	p<0.03	HBO group had severer wounds
		Minor amputation			p<0.005	(p=0.03)
		2-year follow-up			lower mortality	
Oriani et al[8]	115	Amputation	3/62	6/18	p<0.01	part-random only

HBOT is a moderately expensive treatment. In Christchurch, we estimate the cost of a 30-treatment HBOT course, including all wound care and dressings costs to be approximately $13,000 per patient. However, the cost-benefit studies which have been done in the UK and USA show an overall saving by combining HBOT with standard modalities of care in the management of diabetic ulcers, as well as improved outcomes.[4,6] A recent UK study reported an overall saving of approximately NZ$8,000 per patient treated compared to non-HBOT care.[4]

Locally, we have too small a database yet to have a good idea of how well we are doing. However, of the first 50 lower limb ulcers of mixed aetiology (approx. half DM ulcers) referred to HMU, 18 (36%) were healed and 7 (14%) substantially improved on medium-term (approx. 3 month) follow-up; NNT for improvement = 2. There was no major morbidity related to HBOT in these patients.

How HBOT works

HBOT seems to work on the diabetic wound in several ways. Firstly, the intermittent restoration of steep oxygen diffusion gradients in the peri-wound area stimulates fibroblast function in a dose-dependent manner.[10,11] The cyclical pattern of hyperoxygenation/hypoxia leads to the release of local humoral mechanisms promoting wound healing. Recent work suggests a positive effect on nitric oxide metabolism in the diabetic wound. These changes result in an advancing field of neovasculogenesis. At the same time, oedema is reduced improving perfusion, and macrophage function is enhanced, particularly the 'oxygen burst' phase, in the hypoxic diabetic wound. HBOT is known to work synergistically with several antibiotics. Daily HBOT also corrects deficient neutrophil adhesion in Type II diabetes.

Whom to refer for HBOT

Any diabetic patient in whom a wound is not healing after a reasonable period of intensive wound care should be considered for HBOT. The general view internationally is that this includes diabetic patients with an ulcer that is failing to respond after six weeks, or earlier if the ulcer is regarded as limb threatening, and in whom no surgically correctable large vessel disease is present. Operable vascular lesions should be dealt with first. Renal failure and concomitant major proximal arterial disease carry a poorer prognosis for HBOT, just as they do with other interventions. Anecdotally, HBOT has been reported to be particularly useful in the neuropathic and Charcot foot.

The evidence in non-diabetic ulcers is more limited, but the same broad principles apply and HBOT has been shown to enhance healing in one small, prospective, randomised study.[7]

Problem wounds secondary to accidental trauma or medical misadventure in both diabetic and non-diabetic patients may be referred for assessment for HBOT under a prior approval ACC contract that has been in place nationally since March 2002. Many potential referrers are unaware of this ACC-funded service.

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